

Aug. 20, 1957

H. M. SALENTINE

2,803,193

LONG STROKE WELL PUMP RECIPROCATOR

Filed April 9, 1954

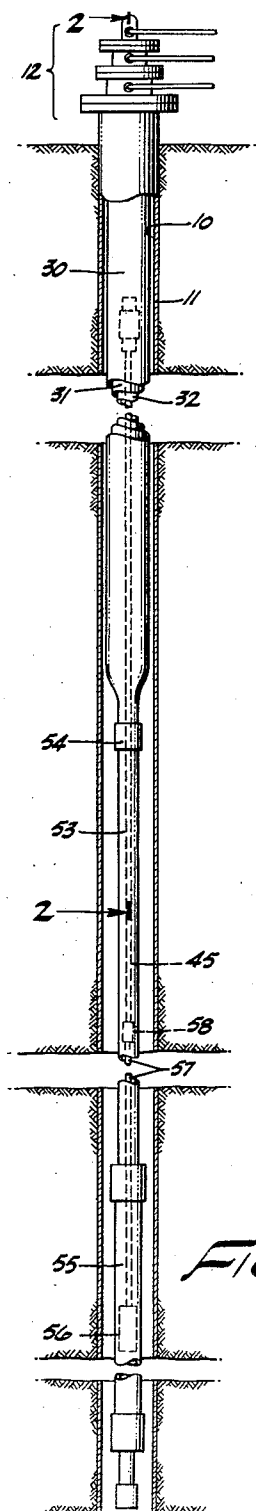


FIG. 1.

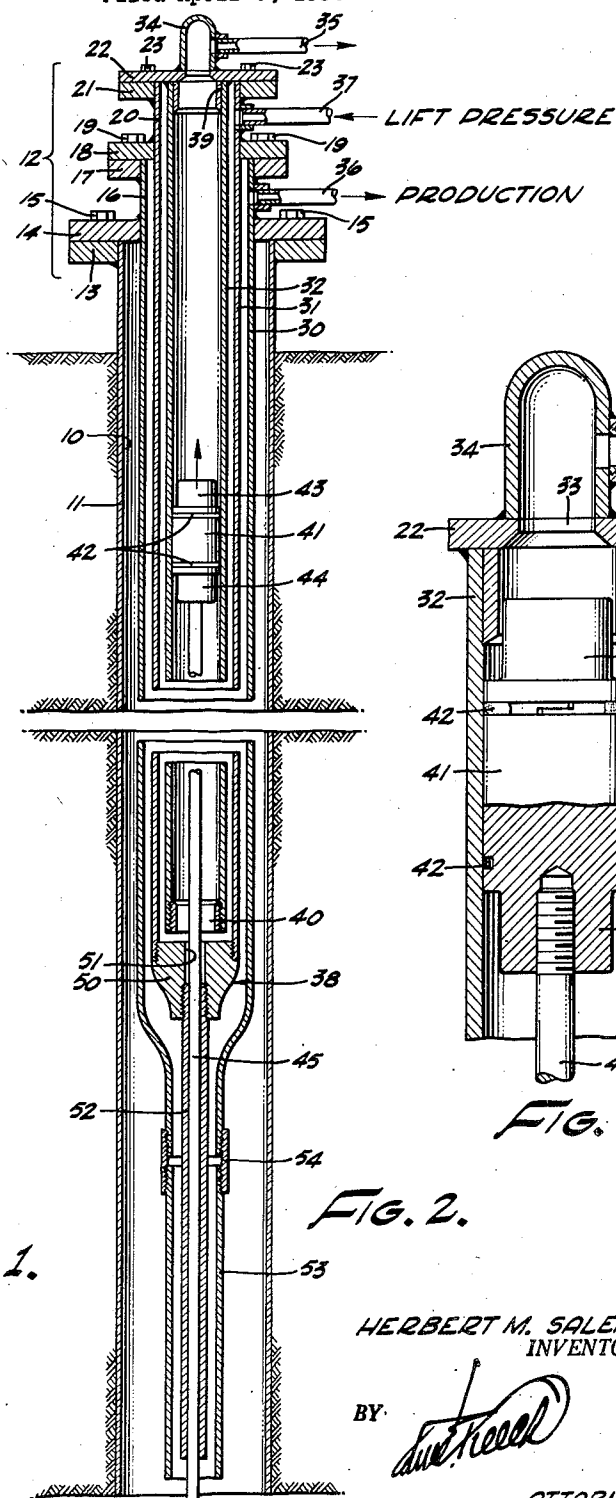


FIG. 2.

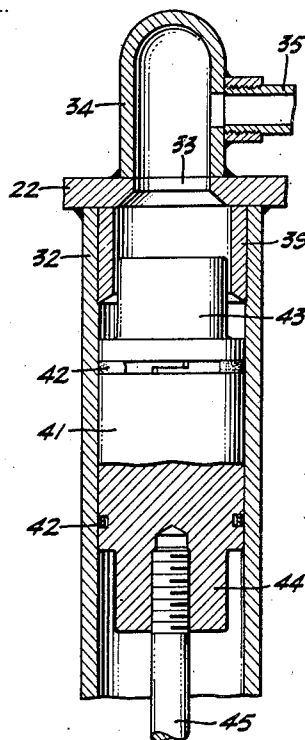


FIG. 3.

HERBERT M. SALENTINE
INVENTOR.

BY

Herbert M. Salentine

ATTORNEY

1

2,803,193

LONG STROKE WELL PUMP RECIPROCATOR

Herbert M. Salentine, Los Angeles, Calif.

Application April 9, 1954, Serial No. 422,075

1 Claim. (Cl. 103—46)

This invention relates to equipment at the top of an oil well for actuating a pump at the bottom of the well through a string of sucker rods and is particularly directed to improving the efficiency of oil production by this means.

As is well known, there is a certain amount of unavoidable elastic stretch in a string of sucker rods which, in very deep wells becomes considerable. Therefore, during each pumping stroke, an initial upward movement of the reciprocator, at the upper end of the well, equivalent in length to that stretch, must occur before the pump plunger on the lower end of the sucker rods responds to the upward movement of the reciprocator. The upward travel of the pump plunger during each pumping stroke is thus equal to the upward movement of the reciprocator less the stretch in the string of sucker rods.

Efforts have been made to increase the rate of production in oil wells by lengthening the stroke of the reciprocator and making fewer strokes per minute. This tends to offset the loss due to sucker rod stretch.

That substantial increases in production efficiency may be realized by increasing the pump stroke is apparent from the following example:

In a 7000 foot well, using a pump plunger 2¼" in diameter and with the sucker rod string divided so that one-third is of 1" diameter rods, one-third is of ¾" diameter rods, and one-third is of ¾" diameter rods, the sucker rod stretch in each pumping stroke is approximately 60" or five feet. Increases in oil production from this well by lengthening the reciprocator stroke may be realized as follows:

Reciprocator Stroke, feet	Sucker Rod Stretch, inches	Number Strokes p. m.	Barrels Daily Production
10	60	4	136
20	60	2	220
30	60	1½	232
40	60	1	253
60	60	¾	297

It is an object of the present invention to provide a sucker rod reciprocator by which oil well pump strokes of practically any desired length may be accomplished whereby advantage may be taken of the higher production rate thus made possible.

Hydraulic reciprocators have been provided heretofore for reciprocating the sucker rod string in a well but the only type proving practical was the external hydraulic reciprocator which is mounted on the upper end of the production tubing and extends vertically upward therefrom. A commonly used reciprocator of this type is that shown in my U. S. Letters Patent No. 2,073,809.

One of the great advantages of this type of reciprocator is the low investment required to install it, as it screws directly onto the upper end of the production tubing and requires no other support. There is a distinct limitation however to the length of stroke which is practical with

2

this type of reciprocator. Not only is it objectionable to increase the visible mechanism above the ground but where the reciprocator height is increased substantially, guy wires or a frame is required to support and facilitate servicing the reciprocator.

It is another object of the invention to provide a hydraulic reciprocator not subject to these objections and by which a reciprocator stroke may be provided of any length desirable, and yet have said reciprocator readily accessible for servicing the same.

A further object of the invention is to provide a reciprocator as aforesaid which is practically entirely enclosed within the uppermost portion of the well casing, and with the reciprocator itself suspended directly from the casing head and removable upwardly from the latter without disturbing the production tubing in the well.

A yet further object of the invention is to provide such a hydraulic pump reciprocator for actuating a sucker rod string extending down through the production tubing to a pump at its lower end and in which the production tubing and the reciprocator are independently suspended at their upper ends from the casing head of the well.

The manner of accomplishing the foregoing objects as well as further objects and advantages will be made manifest in the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a diagrammatic vertical sectional view of an oil well showing a preferred embodiment of the invention installed therein.

Fig. 2 is an enlarged vertical sectional view of the reciprocator of the invention taken at line 2—2 of Fig. 1 illustrating the direct suspension of the reciprocator at its upper end on the multiple step casing head of the invention.

Fig. 3 is a fragmentary enlarged detail view showing the operation of one of the dash pot means of the invention.

Referring specifically to the drawings, an oil well 10 is shown in Figs. 1 and 2 which is provided with a well casing 11 on the upper end of which is mounted a triple-step casing head 12.

This casing head is diagrammatically shown in a simple form of welded construction, which is preferable, but the more complex forms of multi-step casing heads available on the market may be substituted therefor where desired.

The casing head 12 includes an annular flange 13 welded to the upper end of casing 11. A flange 14, secured by bolts 15 to flange 13, is welded to a short tube section 16, to the upper end of which is welded a flange 17. A flange 18, secured by bolts 19 to the flange 17, is welded to a short tube section 20, to the upper end of which is welded a flange 21. A cap plate 22 is secured by bolts 23 to the flange 21.

While tubes suspended from standard multi-step casing heads are separate elements from the casing head itself, the simplified disclosure herein shows such tubes as formed integral with portions of the casing head 12. Thus this disclosure includes telescopically assembled concentric tubes 30, 31 and 32, the first of which is integral with and constitutes a downward extension of tube section 16; the second of which is similarly integral with tube section 20, and the third of which has its upper extremity abutting against and welded to the casing head cap plate 22.

Formed centrally in this plate is a hole 33 which communicates through a hollow dome 34, welded to the plate 22, with a pipe 35, the function of which will later be made clear. Pipes 36 and 37 also connect through tube sections 16 and 20 respectively with the upper ends of tubes 30 and 31.

The tube 32 constitutes the piston cylinder, and the

3

tube 31 the cylinder sleeve of a hydraulic reciprocator 38.

Removably fixed in opposite end portions of the cylinder 32 are dash pot sleeves 39 and 40. The reciprocator also includes a piston 41 which has seal rings 42 and fits slidably into the cylinder 32. Formed on opposite ends of piston 41 are bosses 43 and 44 which are of an outer diameter enabling them to enter respectively the sleeves 39 and 40 with just sufficient clearance to give a desired dash pot action, the purpose of which will be made clear later.

Screwed into a threaded hole formed axially in piston boss 44 is a piston rod (or polish rod) 45 which extends downwardly a substantial distance below the lower end of the reciprocator 38.

Screwed into the threaded lower end of cylinder sleeve 31 is a plug 50 having a central hole 51 for accommodating the rod 45, said hole being counterbored and threaded to receive the upper end of a sealing quill 52 through which the rod 45 slides with only about one thousandth of an inch play. Being about four feet long, the quill 52 forms a practical liquid seal between the lower end of sleeve 31 and rod 45.

The tube 30 is preferably tapered at its lower end to match the diameter of a string of production tubing 53 to which it is joined by a coupling 54. Secured to the lower end of tubing 53 and located in the depths of the well 10 is a reciprocating pump 55. This pump has a plunger 56 which is connected by a string of sucker rods 57 with the lower end of the piston rod 45, through a coupling 58.

The tube 30 is thus seen to provide a housing for the reciprocator 38, a link connecting the production tubing 53 with the casing head 12 for suspending said tubing from said casing head, and a conduit for oil from the upper end of the production tubing to the flow pipe 36.

The tube 30 is preferably made sufficiently long to accommodate a reciprocator 38 of maximum length which for instance might have a stroke of 60 feet. It would then never be necessary to disturb the production tubing 53 in order to install a longer reciprocator when changing production conditions require this. The barrel of the pump 54 must, of course, be sufficiently long to permit a stroke of the plunger 56 matching the maximum stroke of the piston 41, and the original installation would preferably be made with such a pump barrel where the latter is attached to the lower end of production tubing 53.

Operation

Pipe 36 constitutes the production flow line and leads to suitable storage for the oil produced by actuation of the reciprocator 38. Pipes 35 and 37 connect with a suitable pressure responsive hydraulic pumping unit (not shown) which pumps an operating liquid such as a light oil alternately through said pipes into the upper ends respectively of tubes 31 and 32, thereby causing the piston 41 to reciprocate between the upper and lower ends of the cylinder tube 32. This type of unit has an automatic control valve which is responsive to the rise in pressure of the pumped liquid occurring each time the piston 41 is halted by one of the dash pot sleeves 39 and 40, to reverse the direction of flow of said liquid in the pipes 35 and 37, thereby starting a reverse stroke of said piston. The piston 41 is thus repeatedly reciprocated from end to end of the cylinder 32 without interruption.

The initial portion of each upward stroke of the piston 41 is taken up with stretching the sucker rod string 57, after which the balance of said upward stroke accomplishes a corresponding upward movement of the plunger 56 in the well pump 55.

It is believed manifest from the foregoing description, that the present invention provides a simple means, sound in design and accessible for servicing, which solves the

4

problem of employing a much longer stroke in an oil well pump than hitherto practical, in order to attain the much higher net production of oil thus made possible.

While only a single embodiment of the invention is herein disclosed, it is to be understood that many changes might be made in this without departing from the spirit of the invention or the scope of the appended claim.

For instance, the reciprocator 38, which is suspended at its upper end directly from the casing head 12, is herein shown as including two concentric tubes, the cylinder 32 and the sleeve 31. Both of these tubes are connected at their upper ends to said casing head. This is the connection between said reciprocator and said casing head.

The seal between the lower end of sleeve 31 and the polish rod 45 forms a sealed connection between the lower end of cylinder 32 and the space between said cylinder and sleeve 31. Thus the latter space becomes a passage connecting the pipe 37 with the lower end of cylinder 32.

This construction of the reciprocator 38 of the invention is preferable for a number of important reasons. In the first place it provides the simplest and least expensive of the available alternatives for admitting the reciprocator actuating liquid into and from the lower end of the cylinder 32. In the second place it balances the internal pressure of this liquid applied during the lifting stroke to the inner surface of the cylinder 32 beneath the piston 41, by an equal external liquid pressure applied to the outer surface of said cylinder by the liquid between the cylinder 32 and the sleeve 31. This prevents expansion of the cylinder 32 on the high pressure lifting stroke even when a relatively thin walled tube is used for this. In the third place, this preferred construction of the reciprocator 38 provides a separate cylinder for the piston 41 to reciprocate in, which cylinder is suspended at its upper end and has freedom to swing at its lower end to automatically make any slight adjustments required to perfect the alignment between this and the piston 41.

In the fourth place, the provision of a separate tube 32 as the reciprocator cylinder makes it possible to remove this tube for repairs or replacement of this or of the piston 41 by unbolting cap plate 22 and withdrawing this upwardly with the piston 41 suspended on sleeve 40. The piston 41 can then be supported on a split collar inserted between this and the casing head 12, the sleeve 40 can be removed, and the cylinder 32 lifted upwardly from the piston.

In spite of the foregoing advantages of the preferred construction of the reciprocator 38 disclosed, the alternative is available of dispensing with the sleeve 31, extending the internally threaded lower end of cylinder 32 downward to screw directly on the plug 50 and connecting the pipe 37 with the lower end of the cylinder 32 by a pipe extending downward between the cylinder 32 and the tube 30.

Having described the operation of the invention it is desired to point out the following advantages and new results realized by the invention.

The location of the sucker rod reciprocator within the well casing and suspended at its upper end on the casing head itself permits the use of a relatively large outer tube 30 to serve as a housing for the reciprocator 38 and as a support for the oil string 53 which connects with said housing and is suspended therefrom. As the oil string 53 is of much smaller diameter than the outer tube 30, the lower end of the latter is swedged to reduce the diameter thereof to adapt this for connecting with the oil string 53.

The outer tube 30 may be made to accommodate the maximum length of reciprocator 38 (such, for instance, as to accomplish a stroke of 60 feet) and the tube 30 will then be suitable for receiving a reciprocator 38 for effecting any stroke up to the maximum of 60 feet. In

other words, an outer tube 30 of maximum length can be uniformly used in all installations and the length of the reciprocator 38 varied to suit the particular length of stroke desired in each individual well.

Another advantage of the present invention is that reciprocator 38, being suspended from its upper end, and thus in tension, will always seek a correct alignment with a string of rods 45 suspended therefrom and reciprocated thereby. Owing to the fact that the maximum diameter of the well casing is at the uppermost end thereof, a space of maximum diameter is thus provided for the installation of the present invention in which the outer tubular housing 30 and the reciprocator 38 are to be received. This provides an opportunity for utilizing a tube 32 for a motor cylinder which has a relatively large cross-sectional area so as to decrease the pressure required in the operating fluid for lifting the weight of the string of rods suspended from the motor piston as well as the column of pumped oil flowing upwardly through the oil tubing 53.

A further and very important advantage of the present invention is that it provides a reciprocator mechanism which is not only free of the limitation of stroke length, inherent in sucker rod jacks, because these operate under compression, and provides ample piston displacement so as to handle extremely long strings of sucker rods without requiring excessive operating liquid pressure, but it locates the reciprocator mechanism so that it is practically hidden beneath the ground and yet so it can be readily removed independently of the oil string 53 for servicing of the well or any of the equipment therein.

I claim:

In a long stroke hydraulic well pump reciprocator, the combination of: a multiple stepped casing head mounted, when in use, on the upper end of a well casing; three tubes of different diameters, telescopically and concentrically assembled with each tube supported at its upper

end directly on one of the steps of said casing head; a piston slidable in the inner of said tubes; a piston rod connected concentrically to said piston and extending downwardly through and below the lower ends of said tubes for the attachment thereto of a sucker rod for reciprocating said well pump; a plug closing the lower end of the intermediate one of said tubes, said plug being spaced downwardly from the lower end of said inner tube whereby liquid may flow freely back and forth between the lower ends of said inner and intermediate tubes; a sleeve embodied with said plug and slidably receiving said rod to make a substantially liquid tight seal therewith; and means restricting the diameter of the lower end of said outer tube below said plug and forming a connection for the concentric attachment to said outer tube of a string of production pump tubing, on the lower end of which said well pump is suspended; hydraulic means connecting with upper ends of said inner and intermediate tubes for hydraulically reciprocating said piston in said inner tube; and a pipe connecting with the upper end of said outer tube for drawing off production liquid flowing upwardly between said intermediate and outer tubes.

References Cited in the file of this patent

UNITED STATES PATENTS

531,792	Forslund et al.	Jan. 1, 1895
1,746,811	Archer	Feb. 11, 1930
1,802,790	Squires	Apr. 28, 1931
1,907,951	Gage	May 9, 1933
1,933,848	Gage	Nov. 7, 1933
2,073,809	Salentine	Mar. 16, 1937
2,161,922	Goode	June 13, 1939
2,258,493	Hull	Oct. 7, 1941
2,261,752	Buckner	Nov. 4, 1941
2,589,669	Coberly	Mar. 18, 1952
2,589,671	Coberly	Mar. 18, 1952